ACS Nano 2018 vol.12 N4, pages 3985-3993

Revisiting the Mechanism of Oxidative Unzipping of Multiwall Carbon Nanotubes to Graphene Nanoribbons

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Abstract

© 2018 American Chemical Society. Unzipping multiwall carbon nanotubes (MWCNTs) attracted great interest as a method for producing graphene nanoribbons (GNRs). However, depending on the production method, the GNRs have been proposed to form by different mechanisms. Here, we demonstrate that the oxidative unzipping of MWCNTs is intercalation-driven, not oxidative chemical-bond cleavage as was formerly proposed. The unzipping mechanism involves three consecutive steps: intercalation-unzipping, oxidation, and exfoliation. The reaction can be terminated at any of these three steps. We demonstrate that even in highly oxidative media one can obtain nonoxidized GNR products. The understanding of the actual unzipping mechanism lets us produce GNRs with hybrid properties varying from nonoxidized through heavily oxidized materials. We answer several questions such as the reason for the innermost walls of the nanotubes remaining zipped. The intercalation-driven reaction mechanism provides a rationale for the difficulty in unzipping single-wall and few-wall CNTs and aids in a reevaluation of the data from the oxidative unzipping process.

http://dx.doi.org/10.1021/acsnano.8b01617

Keywords

graphene nanoribbons, intercalation, mechanism, unzipping multiwall carbon nanotubes

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